AMENDMENTS TO THE SPECIFICATION

Please replace the paragraphs on page 1, line 3 (numbered line 1) – page 7, line 14 with the following:

BACKGROUND

The invention relates to a method for moving at least two elements of a placement machine ~~in and opposite to~~ in, and opposite to, a predetermined direction, in which the second element is moved by means of the first element. The invention also relates to a placement machine suitable for executing such a method.

~~In such a method and~~ A conventional placement machine ~~known from~~ (and its associated method) is disclosed in international patent application WO 97/38567, in which an arm forming a first element is movable ~~in and opposite to~~ in, and opposite to, a Y direction. To the arm is attached a ~~slide~~ guide forming a second element, which ~~slide~~ guide is moved along with the arm when the latter is moved in Y-direction. In ~~the known machine the slide~~ this machine, the guide is also movable in ~~a transverse~~ another direction ~~extending transversely~~ that extends transverse to the predetermined direction and that is denoted an X direction.

The ~~slide~~ guide comprises a component placement element by means of which a component can be ~~picked up~~ picked-up from a ~~pick up~~ pick-up plate and subsequently can be placed on a desired position onto the substrate. For this ~~purpose~~ purpose, the arm, the ~~slide~~ guide, and the component placement element are moved in common ~~in or opposite to~~ in, or opposite to, the Y-direction and the X-direction. Near to the ~~pick up~~ pick-up position and the desired position on the ~~substrate~~ substrate, the component pick-up element ~~should be~~ is temporarily stopped to enable it to ~~pick up~~ pick-up and place the ~~component~~ component, respectively. To ~~make the relative~~ enable a relatively fast ~~picking up~~ pick-up and placement of components ~~possible~~, the relatively heavy arm and the component placement element are ~~to be~~ moved as fast as possible between the pick-up position and the desired position on the ~~substrate, which~~ substrate.

The rapid movement of the arm and the component placement element leads to relatively large acceleration and deceleration forces. ~~Since, in addition,~~ As the accuracy with which a relatively light component is ~~picked up or moved, respectively,~~ picked-up or moved should be relatively high, stringent requirements ~~are made~~ must be placed on the driving and guiding of the arm. ~~Such a problem~~ This heightened accuracy requirement presents a

problem that is not only found in component placement machines, but in any placement machine with which a relatively small mass is to be moved ~~fast and~~ quickly and by means of a relatively large mass.

SUMMARY

It is an object of the present invention to provide a method for moving at least two elements in which the second element can be moved ~~relatively~~ comparatively accurately and ~~relatively fast~~ quickly to a desired position by means of the first element. This object is achieved in the method according to the invention in that the first element is moved in the predetermined direction while at the same time the second element is moved relative to the first element in a direction opposite to the predetermined direction and vice versa. ~~In this manner~~ Accordingly, it is ~~possible~~ possible, for ~~example~~ example, to move the first element together with the second element to a desired position in a ~~relatively~~ comparatively fast manner.

During ~~this operation,~~ the movement of the first and second elements near the desired ~~position~~ position, the second element is moved in an opposite direction to the first element. As a result, the second element undergoes a ~~compound move~~ compound movement that is in a direction opposite to the predetermined direction and that is determined by ~~the move~~ the movement of the first element in the predetermined direction ~~and the move relative to the second element relative to the first element in the direction opposite to predetermined direction,~~ or vice versa. The compound ~~move of~~ movement of the second element may be ~~relatively~~ comparatively small or even ~~zero, so that~~ zero. As a result, the second element ~~is brought~~ may be brought to a standstill without ~~the need for~~ also bringing the first element ~~to be brought~~ to a relative standstill and, therefore, no ~~as well, so that there will not be any~~ large deceleration forces will be applied to the ~~on the~~ first element.

An embodiment of the method according to the invention is characterized in that the first ~~element is~~ element may be moved in the predetermined direction over a distance that is substantially equal to the distance over which the second element is moved in opposite direction. The resulting or compound distance over which the second element is relatively moved will then be substantially equal to zero. This makes it possible for the first element to be moved, whereas the second element remains relatively stopped.

A further embodiment of the method according to the invention is characterized in that the first element ~~is moved~~ may be moved in the predetermined direction with a speed that is substantially equal to the speed with which the second element is moved in opposite direction. In ~~this way~~ this way, the resulting speed with which the second element is

relatively moved is substantially equal to zero, whereas the speed of the first element need not be adjusted.

A further embodiment of the method according to the invention is characterized in that the second ~~element is~~ element may also be moved in a ~~transverse direction extending transversely~~ direction that extends transverse to the predetermined direction. In this way the second element ~~can be~~ may be moved in a plane ~~extending~~ that extends parallel to the predetermined direction and the transverse direction.

Yet a further embodiment of the method according to the invention is characterized in that the second element ~~comprises~~ may comprise a component placement element ~~which~~ that, relative to the second ~~element~~ element, is moved in a placement direction ~~extending transversely~~ that extends transverse to the predetermined direction. By means of a component placement ~~element~~ element, it is possible for a component to be moved accurately ~~and fast~~ and quickly to a desired position by means of the placement machine.

Yet a further embodiment of the method according to the invention is characterized in that the second element ~~comprises~~ may comprise an imaging device by which ~~images are~~ images may be made. By means of the imaging ~~device~~ device, it is possible to make images of a desired position to which the second element is to be ~~moved, which action is preferably~~ moved; this imaging may be carried out while the second element is being moved. This enables the second element to be driven relative to the first element so that the second ~~element is~~ element may be accurately moved close to the desired position.

The invention is also based on a placement machine that avoids the disadvantages of the ~~known~~ conventional machine. The placement machine according to the invention ~~therefore~~ comprises at least two elements that are movable ~~in and opposite to~~ in, and opposite to, a predetermined ~~direction, the~~ direction. The second element ~~being~~ is movable with the aid of the first ~~element, both~~ element. Both the first element and the second element are further ~~being~~ movable relative to each other ~~in and opposite to~~ in, and opposite to, a predetermined direction. ~~In this way~~ As a result, it is possible to bring the second element to a relative standstill while the first element is ~~moved~~ moving, for ~~example~~ example, at a constant speed, by moving the second element in the opposite direction. The second element mass to be brought to a relative standstill with this action may be ~~relatively~~ comparatively small, so that ~~relatively~~ comparatively small acceleration forces will occur.

~~The invention will be further explained with reference to the drawing in which:~~ It is to be understood that both the foregoing general description and the following detailed

description are exemplary and explanatory only, and are not restrictive of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become apparent from the following description, appended claims, and the accompanying exemplary embodiments shown in the drawings, which are briefly described below.

Fig. 1 is a plan view of a component placement machine ~~that has a placement machine~~ according to the ~~invention,~~ invention;

Fig. 2 ~~gives~~ is a diagrammatic representation of a placement machine according to the invention, in which the second element is located close to the desired placement ~~position,~~ position; and

Fig. 3 ~~shows~~ is a diagrammatic representation of the placement machine shown in Fig. 2 in which the second element is located near a pick-up position.

DETAILED DESCRIPTION

In the Figures like elements carry like reference numerals.

Fig. 1 shows a component placement machine 1 according to the ~~invention, which~~ invention. The component placement machine 1 comprises an elongated frame 2 over which a substrate 3 can be moved ~~in or opposite to~~ in, and opposite to, a direction indicated by arrow P_1. The direction indicated by arrow P_1 extends ~~in parallel with~~ parallel to the X-direction. The component placement machine 1 further comprises two guide rails 4, 5 that are parallel to ~~parallel with~~ each other and ~~extending~~ that extend in the Y-direction, ~~transversely~~ i.e., traverse to the X-direction. The guide rails 4, 5 are located over the frame 2. Between the guide rails 4, 5 is an arm 6 ~~which~~ that on either end comprises a guide ~~7, 8 (= first~~ 7, 8 (i.e., first element) by means of which the arm 6 is slidably supported on bearings over the guide rails 4, 5. The guides 7, 8 each comprise a motor by which the guides 7, 8 are movable over the guide rails 4, 5 in, and opposite to, ~~in and opposite to~~ the directions indicated by the ~~arrow P_2 or P_3,~~ arrows P_2, P_3, respectively. A guide 9 is movable over the arm 6 by means of a motor in, and opposite to, ~~in and opposite to~~ the X-direction indicated by the arrow P_4. ~~The guide 9 comprises at least one component placement machine which in Fig. 1 is hidden from view by the guide 9 and the arm 6.~~ The component placement machine 1 further comprises a number of component feeding devices 10 arranged on both sides of the frame 2 between the guide rails 4, 5.

The component placement machine 1 described so far is known per se, for example, from international patent application WO 97/38567, which was previously discussed.

~~mentioned in the opening paragraph.~~ For this ~~reason~~ reason, the operation of the component placement machine 1 will be ~~elucidated only concisely~~ concisely elucidated. Substrates 3 are moved in steps in the direction indicated by the arrow P_1 over the frame ~~2, with components being~~ 2. Components are positioned on the substrates 3 in the area between the guide rails 4, 5 by means of the component placement element. For this ~~purpose~~ purpose, the guide 9 is moved over the arm 6 while at the same time the guides 7, 8 are moved over the guide rails 4, 5, so that a desired component can be ~~picked up~~ picked-up from the component feeding devices 10 by means of the component placement element. ~~Then the~~ Subsequently, the component placement element is taken to a desired position above the substrate 3 via the guides 7, 8 after which the component is positioned in the Z direction at the desired position on the substrate by means of the component placement element.

The mass of the component to be placed is often less than 1 ~~gram. The~~ gram whereas the total mass of the guides 7, 8, 9 and the arm 6 ~~and the guide 9 is for example~~ is, for example, 65 to 80 kg. During the ~~move in for example Y direction~~ movement in, for example, the Y-direction, this whole mass is constantly ~~to be~~ moved to and fro between the component feeding devices 10 and the desired position on the substrate 3. To be able to place ~~relatively many~~ a comparatively large number of components per time unit, the arm 6 ~~is to~~ must be moved to and fro ~~relatively fast~~ comparatively quickly. It should also be possible to ~~quickly~~ bring the arm 6 to a standstill quickly and to likewise to ~~set in motion again~~ reset the arm 6 in motion quickly.

As a result of the large weight of the arm 6 compared with the weight of the component to be placed, ~~relatively~~ comparatively large acceleration and deceleration forces ~~show up~~ may occur during this ~~action~~ movement. In addition or alternatively, vibrations may occur during this ~~action which are~~ movement; such vibrations must first ~~to be~~ be dampened to achieve the desired positioning ~~accuracy, which~~ accuracy; this damping takes extra time.

~~Such~~ The aforementioned acceleration forces and deceleration forces ~~as well as~~ and/or vibrations do not occur with a component placement machine 11 according to the present invention. The component placement machine 11 ~~according to the invention~~ will be further explained with reference to Figs. 2 and 3. ~~In the placement machine 11 diagrammatically shown in these Figures 2 and 3 is included~~ The component placement machine 11 includes a guide 7 that is movable over a guide rail 4 in, and opposite to, ~~in and opposite to~~ the Y-direction indicated by the arrow P_2. For ~~clarity's sake~~ sake of clarity, the arm 6 and the guide ~~9 has been left out in the placement machine 11 and a guide 13 (= second element) supporting~~ 9 have been omitted in Figs. 2 and 3. A guide 13 (i.e., second element), which

supports a component placement element ~~12 can~~ 12, can be directly moved over a guide rail 14 connected with the guide 7. The guide rail 14 extends parallel to ~~in parallel with~~ the guide rail 4. The guide 13 can be moved ~~in and opposite to a~~ in, and opposite to, the Y-direction, as indicated by arrow P_5. The direction indicated by arrow P_5 extends ~~in parallel with~~ parallel to the direction indicated by arrow P_2.

In the situation shown in ~~Fig. 2~~ Fig. 2, a component 15 has already been fed from the component feeding device 10 by means of the component placement element 12. ~~Component~~ The component 15 is to be placed at a desired position on the substrate 3. For this purpose, the guide 7 together with the connected guide 13 is moved in the direction indicated by arrow P_2 at a ~~relatively~~ comparatively high speed. As soon as the component placement element 12 comes in the neighborhood of the desired position on the substrate 3, the guide 13 is ~~moved~~ moved, by means of a ~~regulator~~ regulator, in the direction indicated by arrow P_5, i.e., opposite to the direction indicated by arrow P_2. The placement of the guide 13 in the direction indicated by the arrow P_5 is regulated such that the component 15 is immobile relative to the ~~substrates~~ substrate 3 above the desired position on the substrate 3 at which the component is to be placed. As ~~and can be placed on the substrate 3. Since~~ only the speed ~~and move~~ and movement of the ~~relatively~~ comparatively light guide 13 needs to be regulated in the neighborhood of the desired position on the substrate 3, the consequent acceleration and deceleration forces will be ~~relatively small, so that~~ comparatively small. As a result, the component 15 can be placed on the substrate 3 with ~~relatively~~ high ~~accuracy~~ accuracy, while the speed at which the total mass of the ~~guide 7 and the guide 13~~ guides 7, 13 is moved in the direction indicated by arrow P_2 can be ~~relatively~~ comparatively high. ~~Besides,~~ Moreover, the mass of the guides 7, 13 can keep moving steadily, thereby precluding ~~so that no~~ attendant acceleration/deceleration forces and/or vibrations ~~will develop~~.

Fig. 3 shows the placement machine 11 represented in Fig. 2 when a component 15 is being ~~picked up~~ picked-up from a component feeding device 10. The guide 7 is first moved in a direction opposite to the arrow P_2 from a position above the substrate 3 to a position located above the component feeding device 10. Subsequently, the guide 7 is to be moved again in the direction indicated by the arrow P_2 to the position located above the substrate 3. This reciprocating ~~move of~~ movement of the guide 7 is indicated by the arrow P_6. To avoid ~~relatively~~ comparatively high acceleration and deceleration forces and/or vibrations, in the neighborhood of the component feeding device ~~10 the~~ 10, the guide 13 is moved in the direction indicated by the arrow P_7 over the guide rail ~~14, the~~ 14. The superposed ~~move of~~ movement of the component placement element 12 ~~being~~ is such that the component

placement element 12 stands still for a moment at the desired position above the component feeding device 10, thereby enabling the component 15 to be picked-up ~~to be able to pick up a component 15~~ from the component feeding device 10. The guide 7 can be slowed down ~~relatively~~ comparatively slowly during the ~~pick up~~ pick-up phase and accelerated again to be able to change direction ~~of move so that~~ of movement, while ensuring that there are ~~relatively~~ comparatively small deceleration and acceleration forces. ~~The relatively~~ In contrast, the light guide 13 can undergo ~~relatively~~ comparatively large decelerations and accelerations ~~which results in relatively~~ that result in comparatively small deceleration and acceleration forces, as a result of the ~~relatively~~ comparatively light weight.

If the placement machine 11 according to the invention is used in the component placement machine 1 shown in Fig. 1, the guide rail 14 can be connected with the guide 9, for example, ~~9 for example~~ on a side of the arm 6 facing the frame 2. Fig. 1 gives a diagrammatic view of such a guide rail 14 having reference numeral 14'.

The guide 7 can be moved with a speed of 2 meters per second, whereas the time needed for ~~picking up~~ picking-up or placing a component ~~being for example~~ may be, for example, 100 ms. ~~The length~~ As a result, the length of the guide rail 14 should ~~then be~~ be about 200 mm to ~~make a sufficient move~~ enable sufficient movement of the guide 13 ~~possible~~.

It is also possible to have the ~~relatively~~ comparatively light guide 13 moveable in both the X and Y directions but ~~in Y and X direction in~~ opposite to the direction of the comparatively ~~to a relatively~~ heavy guide.

It is alternatively possible to provide the guide 9 with a second guide rail 14" by means of which a second component placement element 12 can be moved. In this fashion it is possible to ~~pick up~~ pick-up two components at the same time ~~or in succession~~ (or in succession) from the component feeding devices 10 and then place them simultaneously (or in succession) ~~or in succession~~ on a substrate 3.

It is alternatively possible to provide the guide 13 not only with a component placement element 12 but also with a ~~camera (16)~~ camera 16 (i.e., image sensor) by means of which a pick-up position on the component feeding device 10 ~~can be observed as well as~~ and a desired placement position on the substrate 3 can be observed prior to ~~picking up~~ picking-up and placing a ~~component 15~~ component 15, respectively. Based on the images perceived by the ~~camera (16)~~ camera 16, an accurate driving of the guide 13 relative to the guide rail 14 can be realized. It is also possible for the camera 16 to be installed on a separate ~~slide 13~~ guide that can be moved over a separate guide ~~rail 14~~ rail.

The component placement element ~~12 for example~~ 12, for example, comprises a pick-up tube that can be moved relative to the guide 13 ~~in and opposite to~~ in, and opposite to, the Z direction ~~extending~~ that extends transversely to the X and Y-direction.

Given the disclosure of the present invention, one versed in the art would appreciate that there may be other embodiments and modifications within the scope and spirit of the invention. Accordingly, all modifications attainable by one versed in the art from the present disclosure within the scope and spirit of the present invention are to be included as further embodiments of the present invention. The scope of the present invention is to be defined as set forth in the following claims.